

INCH-POUND

MIL-PRF-19500/354F  
28 April 2000  
SUPERSEDING  
MIL-S-19500/354E  
5 August 1999

## PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, SILICON, LOW-POWER  
TYPES 2N2604 AND 2N2605, JAN, JANTX, JANTXV, AND JANS, JANHC, JANKC

This specification is approved for use by all Departments  
and Agencies of the Department of Defense.

### 1. SCOPE

1.1 Scope. This specification covers the performance requirements for PNP, silicon, low-power transistors for use in low noise-level amplifier applications. Four levels of product assurance are provided for each device type as specified in MIL-PRF-19500.

\* 1.2 Physical dimensions. See figure 1, TO-46 and figure 2, die.

### 1.3 Maximum ratings.

Type	$P_T$ 1/ $T_A = +25^\circ\text{C}$	$V_{CBO}$	$V_{EBO}$	$V_{CEO}$	$I_C$	$T_J$ and $T_{STG}$	$R_{\theta JA}$
	<u>mW</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>mA dc</u>	<u>°C</u>	<u>°C/mW</u>
2N2604	400	80	6	60	30	-65 to +200	0.437
2N2605	400	70	6	60	30	-65 to +200	0.437

1/ Derate linearly at 2.28 mW/°C above  $T_A = +25^\circ\text{C}$ .

### 1.4 Primary electrical characteristics.

	$h_{FE1}$		$H_{fe}$		$ h_{fe} $	$C_{obo}$	$V_{BE(sat)}$	$V_{CE(sat)}$
	$V_{CE}=5\text{ V dc}$ $I_C=10\text{ }\mu\text{ dc}$		$V_{CE}=5\text{ V dc}$ $I_C=1\text{ mA dc}$ $f=1\text{ kHz}$		$V_{CE}=5\text{ V dc}$ $I_C=500\text{ }\mu\text{A dc}$ $f=30\text{ MHz}$	$V_{CB}=5\text{ V dc}$ $I_E=0$ $100\text{ kHz} \leq f \leq 1\text{ MHz}$	$I_C=10\text{ mA dc}$ $I_B=500\text{ }\mu\text{A dc}$	$I_C=10\text{ mA dc}$ $I_B=500\text{ }\mu\text{A dc}$
Min	2N2604	2N2605	2N2604	2N2605		<u>pF</u>	<u>V dc</u>	<u>V dc</u>
Max	40	100	60	150	1	6	0.7	0.3
	120	300	180	450	8		0.9	

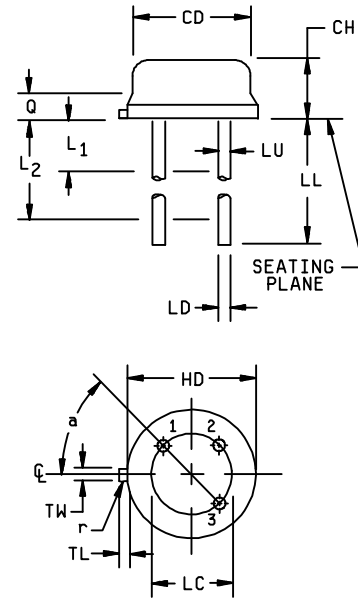
Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Defense Supply Center Columbus, ATTN: DSCC-VAC, 3990 East Broad St., Columbus, OH 43216-5000, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 5961

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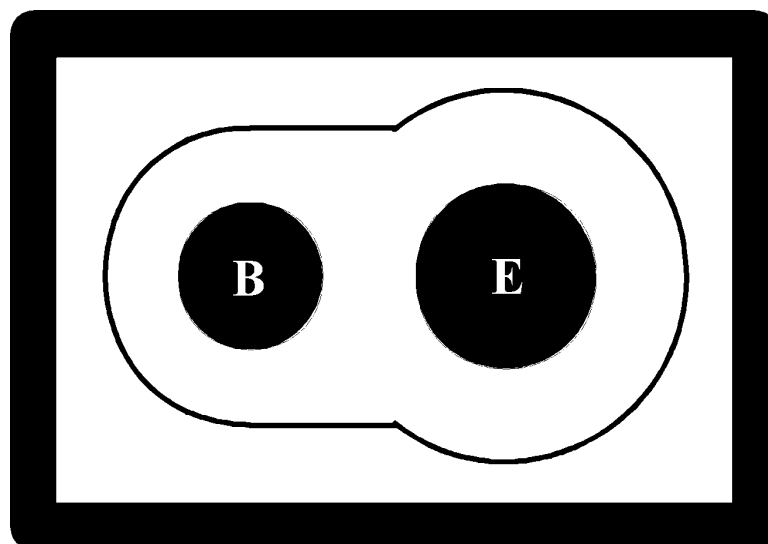
Symbol	Dimensions				Note
	Inches		Millimeters		
	Min	Max	Min	Max	
CD	.178	.195	4.52	4.95	
CH	.065	.085	1.65	2.16	
HD	.209	.230	5.31	5.84	
LC	.100 TP		2.54 TP		5
LD	.016	.021	0.41	0.53	6
LL	.500	1.750	12.70	44.45	6
LU	.016	.019	0.41	0.48	6
L1	---	.050	---	1.27	6
L2	.250	---	6.35	---	6
Q	---	.040	---	1.02	4
TL	.028	.048	0.71	1.22	3, 8
TW	.036	.046	0.91	1.17	3, 8
r	---	.010	---	0.25	9
$\alpha$	45° TP		45° TP		5



## NOTES:

1. Dimensions are in inches. Lead 1 is emitter, lead 2 is base, and lead 3 is collector.
2. Metric equivalents are given for general information only.
3. Symbol TL is measured from HD maximum.
4. Details of outline in this zone are optional.
5. Leads at gauge plane  $.054 +.001 -.000$  inch ( $1.37 +0.03 -0.00$  mm) below seating plane shall be within  $.007$  inch ( $0.18$  mm) radius of true position (TP) at maximum material condition (MMC) relative to tab at MMC. The device may be measured by direct methods or by the gauge and gauging procedure.
6. Symbol LU applies between  $L_1$  and  $L_2$ . Dimension LD applies between  $L_2$  and LL minimum.
7. Lead number three is electrically connected to case.
8. Beyond  $r$  maximum, TW shall be held for a minimum length of  $.011$  inch ( $0.28$  mm).
9. Symbol  $r$  applied to both inside corners of tab.
10. In accordance with ANSI Y14.5M, diameters are equivalent to  $\phi$ x symbology.

FIGURE 1. Physical dimensions – TO-46.



- |                   |  |
|-------------------|--|
| 1. Chip size      | 15 x 19 mils $\pm$ 1 mil   |
| 2. Chip thickness | 10 $\pm$ 1.5 mil   |
| 3.                | Top metal Aluminum 15,000Å minimum, 18,000Å nominal                              |
| 4.                | Back metal A. Gold 2,500Å minimum, 3,000Å nominal<br>B. Eutectic Mount – No Gold |
| 5. Backside       | Collector  |
| 6. Bonding pad    | B = 3 mils, E = 4 mils diameter  |
| 7. Passivation    | Si <sub>3</sub> N <sub>4</sub> (Silicon Nitride) 2kÅ min, 2.2kÅ nom.             |

\* FIGURE 2. JANHC and JANKC A-version die dimensions.

## 2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

### 2.2 Government documents.

2.2.1 Specifications, standards and handbooks. The following specifications, standards and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

## SPECIFICATION

### DEPARTMENT OF DEFENSE

MIL-PRF-19500 - Semiconductor Devices, General Specification for.

## STANDARD

### DEPARTMENT OF DEFENSE

MIL-STD-750 - Test Methods for Semiconductor Devices.

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Defense Automated Printing Service, 700 Robbins Avenue, Building 4D (DPM – DODSSP), Philadelphia, PA 19111-5094.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated specifications or specification sheets), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

## 3. REQUIREMENTS

3.1 Associated specification. The individual item requirements shall be in accordance with MIL-PRF-19500, and as specified herein.

3.2 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in MIL-PRF-19500.

\* 3.3 Interface requirements and physical dimensions. The Interface requirements and physical dimensions shall be as specified in MIL-PRF-19500 and figure 1, TO-46, and figure 2 (die).

3.3.1 Lead finish. Lead finish shall be solderable in accordance with MIL-PRF-19500, MIL-STD-750 and herein. Where a choice of lead finish is desired, it shall be specified in the acquisition document (see 6.2).

3.4 Marking. Marking shall be in accordance with MIL-PRF-19500.

3.5 Electrical performance characteristics. Unless otherwise specified herein, the electrical performance characteristics are as specified in paragraph 1.3, 1.4, and table I.

3.6 Electrical test requirements. The electrical test requirements shall be the subgroups specified in table I herein.

3.7 Qualification. Devices furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified manufacturers list before contract award (see 4.2 and 6.4).

#### 4. VERIFICATION

4.1 Classification of Inspections. The inspection requirements specified herein are classified as follows:

- a. Qualification inspection (see 4.2).
- b. Screening (see 4.3)
- c. Conformance inspection (see 4.4).

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-PRF-19500.

4.3 Screening (JANS, JANTX, and JANTXV levels only). Screening shall be in accordance with table IV of MIL-PRF-19500, and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

Screen (see table IV of MIL-PRF-19500)	Measurement	
	JANS level	JANTX and JANTXV levels
9	$I_{CBO1}$ and $h_{FE1}$	Not applicable
11	$I_{CBO1}$ ; $h_{FE1}$ ; $\Delta I_{CBO1}$ = 100 percent or 2 nA dc, whichever is greater; $\Delta h_{FE1}$ = $\pm 25$ percent change of initial value.	$I_{CBO1}$ and $h_{FE1}$
12	See 4.3.1	See 4.3.1
13	Subgroups 2 and 3 of table I herein; $\Delta I_{CBO1}$ = 100 percent or 2 nA dc, whichever is greater; $\Delta h_{FE1}$ = $\pm 25$ percent change of initial value.	Subgroup 2 of table I herein; $\Delta I_{CBO1}$ = 100 percent or 2 nA dc, whichever is greater; $\Delta h_{FE1}$ = $\pm 25$ percent change of initial value.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows:

$V_{CB} = 10 - 30$  Vdc,  $T_A$  = room ambient as defined in 4.5 of MIL-STD-750 and as follows:

##### Condition A - Self Heating Burn-in criteria

Power shall be applied to the device to achieve a junction temperature,  $T_j = 135$  degrees C. The device manufacturer may exceed the maximum power rating during burn-in to achieve the specified  $T_j$  provided the device has been characterized to insure that this conditioning is not detrimental to the device reliability. If this option is used it is the responsibility of the manufacturer to insure that the chosen Voltage and Current does not exceed the SOA characteristics of the device.

##### Condition B - External Heating Burn-in

If the specified junction temperature is not achieved with the application of maximum rated power, then, at the device manufacturer's option, external heating may be applied to meet the specification requirement. When the external heating option is used, a minimum of 75% of the max rated power shall be applied to the device under test. The minimum power dissipated must be greater than or equal to the rated power.

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-PRF-19500, and table I herein. Electrical measurements (end-points) shall be in accordance with the applicable inspections of table I, group A, subgroup 2 herein.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in tables VIa (JANS) and VIb (JAN, JANTX, and JANTXV) of MIL-PRF-19500 and paragraphs 4.4.2.1 and 4.4.2.2 herein. Electrical measurements (end-points) shall be in accordance with the applicable inspections of table I, group A, subgroup 2 herein.

4.4.2.1 Group B inspection, table VIa (JANS) of MIL-PRF-19500.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B3	2027	Condition A
B4	1037	$V_{CB} = 20 \text{ V dc}$ ; $P_T = 400 \text{ mW}$ at $T_A = \text{room ambient}$ as defined in 4.5 of MIL-STD-750; $t_{on} = t_{off} = 3 \text{ minutes}$ minimum for 2,000 cycles. No heat sink or forced-air cooling on devices shall be permitted.
B5	1027	$V_{CB} = 20 \text{ V dc}$ ; $T_A = +125^\circ\text{C} \pm 25^\circ\text{C}$ for 96 hours, $P_T = 400 \text{ mW}$ at $T_A = +100^\circ\text{C}$ or adjusted as required by the chosen $T_A$ to give an average lot. $T_J = +275^\circ\text{C}$
B6	3131	$R_{\theta JA} = .437^\circ\text{C/mW}$ .

\* 4.4.2.2 Group B inspection, table VIb (JAN, JANTX and JANTXV) of MIL-PRF-19500.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B3	1027	$V_{CB} \geq 10 \text{ V dc}$ ; adjust $P_T$ to achieve $T_J = 150^\circ\text{C}$ minimum. $T_A = \text{room ambient}$ as defined in 4.5 of MIL-STD-750. No heat sink or forced-air cooling on the devices shall be permitted.
B3	2037	Condition A
B5	3131	$R_{\theta JA} = .437^\circ\text{C/mW}$

\* 4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table VII of MIL-PRF-19500, and as follows. Electrical measurements (end-points) shall be in accordance with table I, group A, subgroup 2 herein.

4.4.3.1 Group C inspection, table VII of MIL-PRF-19500.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
C2	2036	Test condition E
C6	1026	$V_{CB} \geq 10 \text{ V dc}$ ; adjust $P_T$ to achieve $T_J = 150^\circ\text{C}$ minimum. $T_A = \text{room ambient}$ as defined in 4.5 of MIL-STD-750. No heat sink or forced-air cooling on device shall be permitted.

4.5 Methods of inspection. Methods of inspection shall be as specified in the appropriate tables and as follows.

4.5.1 Pulse measurements. Conditions for pulse measurements shall be as specified in section 4 of MIL-STD-750.

4.5.2 Noise figure. The noise figure shall be measured using commercially available test equipment and its associated standard test procedures.

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical examination	2071					
<u>Subgroup 2</u>						
Collector - base breakdown voltage 2N2604 2N2605	3001	Bias condition D; $I_C = 10 \mu A$ dc	$V_{(BR)CBO}$	80 70		V dc V dc
Collector - emitter breakdown voltage	3011	Bias condition D; $I_C = 10$ mA dc; pulsed (see 4.5.1)	$V_{(BR)CEO}$	60		V dc
Emitter - base breakdown voltage	3026	Bias condition D; $I_E = 10 \mu A$ dc	$V_{(BR)EBO}$	6		V dc
Collector - base cutoff current	3036	Bias condition D; $V_{CB} = 50$ V dc	$I_{CBO1}$		10	nA dc
Emitter - base cutoff current	3061	Bias condition D; $V_{EB} = 5$ V dc	$I_{EBO}$		2	nA dc
Collector - emitter cutoff current	3041	Bias condition C; $V_{CE} = 50$ V dc	$I_{CES}$		10	nA dc
Forward current transfer ratio 2N2604 2N2605	3076	$V_{CE} = 5$ V dc; $I_C = 10 \mu A$ dc	$h_{FE1}$	40 100	120 300	
Forward current transfer ratio 2N2604 2N2605	3076	$V_{CE} = 5$ V dc; $I_C = 500 \mu A$ dc	$h_{FE2}$	60 150	180 450	
Forward current transfer ratio 2N2604 2N2605	3076	$V_{CE} = 5$ V dc; $I_C = 10$ mA dc	$h_{FE3}$	40 100	160 400	
Base - emitter voltage (saturated)	3066	Test condition A; $I_C = 10$ mA dc; $I_B = 500 \mu A$ dc	$V_{BE(sat)}$	0.7	0.9	V dc
Collector - emitter voltage (saturated)	3071	$I_C = 10$ mA dc; $I_B = 500 \mu A$ dc	$V_{CE(sat)}$		0.3	V dc

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 3						
High-temperature operation:		T <sub>A</sub> = +150°C				
Collector - base cutoff current	3036	Bias condition D; V <sub>CB</sub> = 50 V dc	I <sub>CBO2</sub>		5	μA dc
Low-temperature operation:		T <sub>A</sub> = -55°C				
Forward current transfer ratio 2N2604 2N2605	3076	V <sub>CE</sub> = 5 V dc; I <sub>C</sub> = 10 μA dc	h <sub>FE4</sub>	15 30		
Subgroup 4						
Small-signal short-circuit input impedance 2N2604 2N2605	3201	V <sub>CE</sub> = 5 V dc; I <sub>C</sub> = 1 mA dc; f = 1 kHz	h <sub>ie</sub>	1 2	10 20	kΩ kΩ
Small-signal open-circuit reverse-voltage transfer ratio	3211	V <sub>CE</sub> = 5 V dc; I <sub>C</sub> = 1 mA dc;  f = 1 kHz	h <sub>re</sub>		10 x 10 <sup>-4</sup>	
Small-signal open-circuit output admittance 2N2604 2N2605	3216	V <sub>CE</sub> = 5 V dc; I <sub>C</sub> = 1 mA dc; f = 1 kHz	h <sub>oe</sub>		40 60	μmhos μmhos
Small-signal short-circuit forward-current transfer ratio 2N2604 2N2605	3206	V <sub>CE</sub> = 5 V dc; I <sub>C</sub> = 1 mA dc; f = 1 kHz	h <sub>fe</sub>	60 150	180 450	
Magnitude of common emitter small-signal short-circuit forward- current transfer ratio	3306	V <sub>CE</sub> = 5 V dc;  I <sub>C</sub> = 0.5 mA dc; f = 30 MHz	h <sub>fe</sub>	1	8	
Open circuit output capacitance	3236	V <sub>CB</sub> = 5 V dc; I <sub>E</sub> = 0; 100 kHz ≤ f ≤ 1 MHz	C <sub>obo</sub>		6	pF
Noise figure	3246	V <sub>CE</sub> = 5 V dc; I <sub>C</sub> = 10 μA dc; R <sub>g</sub> = 10 kΩ; f = 100 Hz	F <sub>1</sub>		5	dB
Noise figure	3246	V <sub>CE</sub> = 5 V dc; I <sub>C</sub> = 10 μA dc; R <sub>g</sub> = 10 kΩ; f = 1 kHz	F <sub>2</sub>		3	dB
Noise figure	3246	V <sub>CE</sub> = 5 V dc; I <sub>C</sub> = 10 μA dc; R <sub>g</sub> = 10 kΩ; f = 10 kHz	F <sub>3</sub>		3	dB

1/ For sampling plan, see MIL-PRF-19500



## 5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of material is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Points' packaging activity within the Military Department or Defense Agency, or within the Military Departments' System Command. Packaging data retrieval is available from the managing Military Departments' or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

## 6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Notes. The notes specified in MIL-PRF-19500 are applicable to this specification.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Issue of DODISS to be cited in the solicitation and, if required, the specified issue of individual documents referenced (see 2.2.1).
- b. Lead finish (see 3.3.1).
- c. Type designation and product assurance level.
- d. Packaging requirements (see 5.1).

6.3 Changes from previous issue. The margins of this specification are marked with asterisks to indicate where changes from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

6.4 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Manufacturer's List QML-19500 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Defense Supply Center Columbus, DSCC-VQE, Columbus, OH 43216.

6.4 Suppliers of JANHC and JANKC die. The qualified JANHC and JANKC suppliers with the applicable letter version (example, JANHCA2N2604) will be identified on the QPL.

JANC ordering information	
PIN	Manufacturer
	43611
2N2604 2N2605	JANHCA2N2604 JANKCA2N2604 JANHCA2N2605 JANKCA2N2605

Custodians:

Army - CR  
Navy - EC  
Air Force - 11  
NASA - NA  
DLA - CC

Preparing activity:

DLA - CC

Review activities:

Army - AR, AV, MI  
Navy - AS, CG, MC  
Air Force - 13, 19

(Project 5961-2247)

## STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

### INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

<b>I RECOMMEND A CHANGE:</b>	1. DOCUMENT NUMBER MIL-PRF-19500/354F	2. DOCUMENT DATE
<b>3. DOCUMENT TITLE</b> SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, SILICON, LOW-POWER, TYPES 2N2604 AND 2N2605, JAN, JANTX, JANTXV, JANS, JANHC AND JANKC		
<b>4. NATURE OF CHANGE</b> (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)		
<b>5. REASON FOR RECOMMENDATION</b>		
<b>6. SUBMITTER</b>		
a. NAME (Last, First, Middle initial)	b. ORGANIZATION	
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) COMMERCIAL DSN FAX EMAIL	7. DATE SUBMITTED
<b>8. PREPARING ACTIVITY</b>		
a. Point of Contact Alan Barone	b. TELEPHONE Commercial      DSN      FAX      EMAIL 614-692-0510      850-0510      614-692-6939      alan_barone@dsccl.dla.mil	
c. ADDRESS Defense Supply Center Columbus, ATTN: DSCC-VAC, 3990 East Broad Street, Columbus, OH 43213-1999	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Standardization Program Office (DLSC-LM) 8725 John J. Kingman, Suite 2533, Fort Belvoir, VA 22060-6221 Telephone (703) 767-6888      DSN 427-6888	